Contents lists available at ScienceDirect

Asian Pacific Journal of Tropical Medicine

journal homepage:www.elsevier.com/locate/apjtm

Document heading doi:

Correlates of first dose of measles vaccination delivery and uptake in Indonesia

Renae Fernandez[1], Anu Rammohan[2], Niyi Awofeso[1,3*]

[1]School of Population Health, University of Western Australia, Australia
[2]School of Business, Discipline of Economics, University of Western Australia, Australia
[3]School of Public Health and Community Medicine, University of New South Wales, Australia

ARTICLE INFO

Article history:
Received 2 November 2010
Received in revised form 27 November 2010
Accepted 15 December 2010
Available online 20 February 2011

Keywords:
Measles
Indonesia
Vaccination
Rural-urban differences
Maternal education

ABSTRACT

Objective: To determine health systems-related, familial, and cultural factors which influence the delivery and uptake of measles vaccination in Indonesia. **Methods:** Logistic regression analysis of data collected during the 2007 Indonesian Demographic and Health Survey was undertaken by the authors to investigate these factors. The 2007 Indonesian Demographic and Health Survey dataset is a nationally representative, randomly sampled survey containing 15 065 children aged between 9 and 59 months. **Results:** 72.8% of children had received the measles vaccine. Vaccination coverage was similar for males and females; however, coverage was higher amongst urban children, 80.1%, compared to 68.5% in rural areas. The key findings of the regression analysis were congruent with the results of previous research targeting vaccination coverage. After controlling for all other factors, maternal age, maternal education, wealth, the use of a skilled birth attendant, and postnatal check-ups were positively and significantly ($P< 0.01$) correlated with measles vaccination. The number of children per household was negatively correlated ($P<0.01$). **Conclusions:** In order to enhance measles vaccination coverage in Indonesia, delivery to, and uptake by, rural and low socio-economic populations require substantial improvements. Mass health education and health systems improvements are also required.

1. Introduction

Measles is a common childhood virus that is spread via the respiratory route. The virus is a member of the genus *Morbillivirus* in the family *Paramyxoviridae* and is closely related to the rinderpest virus, which occurs in cattle[1,2]. Divergence of measles virus from the rinderpest virus is estimated to have occurred during the 11th and 12th centuries, when humans and cattle began living in close proximity on farms[2]. The measles virus itself, only occurs in humans[3].

Measles is a highly contagious, yet vaccine preventable, virus, with a case fatality rate of up to 10%. More than 20 million people are affected by measles each year, with 164 000 resulting in death[4]. The majority of measles deaths occur amongst children under-five years and in developing countries with low income and poor health infrastructure. Measles outbreaks in developed countries are usually linked to an imported case or recent travel to areas where the virus is endemic[5]. Symptoms include high fever, cough, coryza and conjunctivitis. A maculopapular rash appears three-four days after these initial symptoms. Infected individuals are contagious four days before and after the onset of the rash. The complications of infection, including blindness, severe diarrhoea, protein-energy malnutrition, respiratory infection and encephalitis, are often the cause of mortality[3].

Measles immunisation is an important indicator of child health and development and has been selected as an indicator of progress towards the Millennium Development Goals. Since 2000, there has been a 78% reduction in measles mortality as a result of improved vaccine coverage worldwide[4]. The World Health Organization (WHO) proposes that greater than 90% immunisation coverage is required in order to reduce the burden of measles mortality. Coverage must reach at least 95% to eliminate endemic measles. In countries like Indonesia where measles is endemic, the WHO recommends that the first dose measles containing vaccine (MCV1) be given at nine months of age[3].

Indonesia is ranked 111 on the Human Development Index with a GDP per capita in 2009 of US$4 000[6]. The World Bank's 2009 estimate of Indonesia's population was 229 964 723, with 52.6% residing in urban areas[7].

*Corresponding author: Professor Niyi Awofeso, MB ChB, PhD, School of Population Health, University of Western Australia, 35 Stirling Highway, Crawley 6009, Australia.
Tel: +61 8 64881282
Fax: +61 8 64881188
E-mail: niyi.awofeso@uwa.edu.au

In addition to having a relatively large rural population, Indonesia's population is spread over 6 000 of its 17 000 islands[8]. Although measles vaccination coverage rates are relatively high, incomplete vaccination and disparities across population groups exist. This may be attributed to uneven distribution of health services in urban, rural and remote areas and across socio-economic groups[9]. In 2008, Indonesia recorded the third highest measles incidence in the WHO South East Asia Region, of 6.73 per 100 000[10]. Figure 1 summarises measles vaccination trends in Indonesia between 1983 and 2008. School based measles immunisation began in 2002 and Supplementary Immunisation Activities (SIAs) were conducted during 2006 and 2007.This graph was presented at the Global Immunisation Meeting, New York 2009 by the Director of Surveillance Epidemiology and Immunization, Ministry of Health, Indonesia. Data source: Surveillance Unit, Ministry of Health[11].

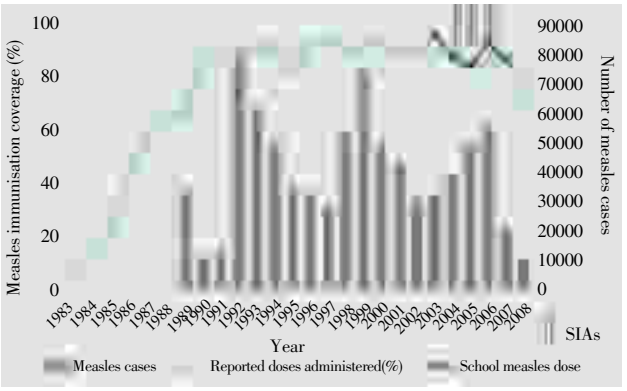

Figure 1. Measles immunisation coverage and reported measles cases in Indonesia from 1983 to 2008.

The 2007 Indonesian Demographic and Health Survey (IDHS) collected data relating to measles vaccination as well as household demographic and socio-economic information. The current study will use data from this survey to investigate the correlates of first dose measles vaccination delivery and uptake among Indonesian children aged under-five years of age. The following research questions were explored; what is the first measles vaccination coverage as determined by the IDHS survey, and how does this compare with Indonesia's health ministry reports as well as with regional trends for measles vaccination in South East Asia? What is the influence of the following factors on the delivery and receipt of the first dose measles vaccination in Indonesia; maternal age; maternal education; wealth; the use of a skilled birth attendant; postnatal check-ups; number of children per household?

2. Methods and materials

2.1. Survey design and participants

The IDHS is a dataset is a nationally representative, randomly sampled cross-sectional survey administered by Statistics Indonesia[12]. Datasets are produced by ORC Macro for the Measure DHS (Demographic and Health Surveys) Project, which is funded by the US Agency for International Development. The IDHS consists of three household level questionnaires, focusing on, ever-married women aged 15-49 years and married men aged 15-54 years. Data was collected between 25 June 2007 and February 2008 via face to face interviews with participants at their homes. The IDHS collects data from representative samples of women and men using a clustered sampling design. The primary sampling unit is the census block, with households selected from the sampling frame developed for the 2007 National Labour Force Survey. Selection of census blocks in urban and rural areas was completed via multistage stratified sampling. The household questionnaire was completed by 40 701 out of 42 341 sampled households (response rate 99%) and was used to identify participants for the women's and men's questionnaires[12].

The analysis in this study will use data from the children's dataset component of the IDHS. Retrospective information on all children born in the household in the five years preceding the survey was collected through the married women's questionnaire and separated into a children's dataset by ORC Macro. Of the 34 227 identified in the household surveys, 32 895 women successfully completed the ever-married women questionnaire (response rate 96%). Children aged less than nine months old were excluded from analysis, as the Indonesian vaccination schedule recommends that routine measles vaccination should be given at this age.

The objectives of the IDHS include measurement of child health indictors such as immunisation coverage and nutritional status, assessing coverage of maternity services and investigating the direct and indirect factors that influence maternal and child health. Murray *et al*[12] investigated the validity of household surveys for the measurement of immunisation coverage, and rated the DHS the best available gold standard for comparison of immunisation data. Investigations of the quality of DHS methodologies concluded that it is nationally representative and relatively free of systematic bias.

2.2. Outcome variable

The outcome variable of interest is measles immunisation amongst children under-five years. The IDHS measured measles vaccination coverage using several response options, which indicated whether the response came from health card vaccination records or mothers' recall. Although 77.6% of respondents indicated that the child had a health card, only 20.8% health cards had complete vaccination data. For the purposes of this analysis, measles vaccination was re-coded into a dichotomous (no/yes) variable. This combined the responses, regardless of the source of the information, into no and yes categories. Children whose mother indicated that they did not know whether measles vaccination had been given (1.33%) were classified as not having received the vaccination. The fact that they have responded 'don't know' is likely to reflect that the child was not vaccinated and fits better with the 'no' response. The small size of the 'don't know' sample indicates that there is little likelihood of a bias in combining this group with the 'no' responses. Maternal recall may be considered a valid measure of child vaccination coverage in the absence of vaccination records in developing countries[14].

2.3. Independent variables

The independent variables under investigation can be

classified into two main categories. The selection of variables was based on a review of the literature and the variables available in the IDHS datasets. The first category relates to the socio-demographic variables, which have consistently been shown to influence vaccination coverage in Indonesia and other developing countries[15-17]. The second category considers factors that are associated with access to and use of health care services, which are important determinants of vaccination coverage, as health care services are unequally distributed across Indonesian provinces and urban/rural areas[18].

Socio-demographic variables include maternal age in years, maternal education defined as no education (reference category), primary, secondary or higher education, wealth defined as poorest (reference category), poorer, middle , richer, richest and the number of children under five living in the household. Health services variables included the use of a skilled birth attendant (no/yes) and access to a postnatal check-up within two months of the child's birth (no/yes). For all dichotomous (no/yes) variables, 'no' was used as the reference category.

2.4. Data analysis

All data analysis was conducted using PASW (SPSS) Version 17. The original dataset was cleaned by removing children who were aged less than nine months and those who were not alive at the time of the survey. Collinearity statistics were produced using the procedure recommended by Pallant[19] to identify any independent variables that were highly correlated. Review of the tolerance values and variance inflation factor (VIF) suggested no evidence of multi-collinearity.

A binomial logistic regression model was developed with measles vaccination as the outcome variable. All independent variables of interest (maternal age, maternal education, wealth, number of children per household, skilled birth attendance and postnatal check-ups) were entered simultaneously into the model, while controlling for the sex of the child, type of residence (urban or rural), island region, religion, paternal education, maternal and paternal occupation, household size, knowing where to go for medical care, distance to medical care, access to a vehicle and having to take transport to medical care. This logistic regression analysis was performed for the whole sample, and repeated for the urban and rural samples respectively. The Wald statistic was used to test the significance of the individual independent variables. The results are reported as odds ratios (*OR*) and the 95% confidence intervals (*CI*) for the odds ratios.

This study did not require ethics approval as it involved the use of unidentifiable secondary data. This data was collected by ORC Macro, who received ethics approval to conduct the IDHS in 2007.

3. Results

The IDHS dataset contained information for 18 645 children whose mother's completed the married women's questionnaire. The number of children under nine months, and therefore not old enough to have received the first routine measles vaccination, was 2 906. These were excluded from analysis, as well as, 674 children over nine months who were deceased at the time of the IDHS. The final sample therefore, contained 15 065 children aged between nine and 59 months who were alive at the time of the survey. Descriptive statistics for the sample are provided in Table 1. Mean child age is 33.9 months, Mean maternal age is 30.04 years, and Mean children per household are 1.45.

Table 1
Showing the socio-demographic characteristics (%).

Characteristics	Categories	Percentage
Measles immunisation	No	27.0
	Yes	72.8
	Missing	0.1
Sex of the child	Male	52.3
	Female	47.7
Place of residence	Urban	38.1
	Rural	61.9
Wealth	Poorest	30.5
	Poorer	20.0
	Middle	17.1
	Richer	16.5
	Richest	15.8
Maternal education	No education	4.4
	Primary	39.7
	Secondary	48.2
	Higher	7.8
Skilled birth attendant	No	30.7
	Yes	69.3
Postnatal check-up	No	16.3
	Yes	83.1
	Missing/Don't know	0.6

3.1. Measles vaccination coverage

In total, 72.8% of children had received measles containing vaccine (MCV). Measles vaccination coverage was similar for males (72.3%) and females (73.6%). Vaccination coverage was higher among urban children (80.1%) compared to children in rural areas (68.5%). After controlling for all other factors, the odds of measles immunisation were not significantly different for male and female children or urban and rural residents. This figure is lower than the 81% measles vaccination coverage reported by Indonesia's health ministry for 2006-2008. Regionally, Indonesia's measles vaccination coverage is significantly less than the average vaccination coverage in the South East Asia region[20].

3.2. Socio-demographic factors

Maternal age was positively correlated with measles vaccination for all three samples ($P<0.01$). Maternal age squared was also found to be significant, suggesting that the relationship between maternal age and measles vaccination is curved. Further analysis (Figure 2) showed that the percentage of immunised children increased as maternal age group increased up to the 30-34 age groups and then decreased, for the combined and rural samples. For the urban sample, the proportion of children immunised increased with each successive maternal age group up to 35-39 years and then began to decline.

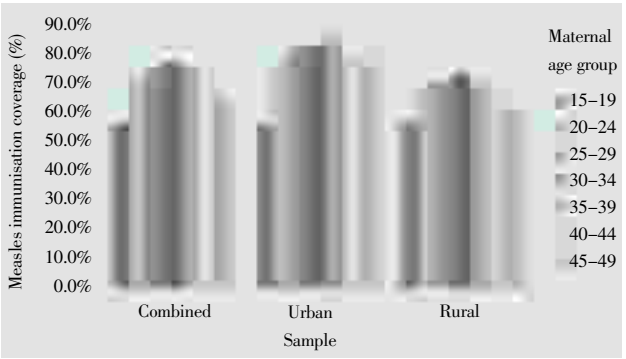

Figure 2. The percentage of children receiving measles.

Maternal highest education level was significantly correlated with measles vaccination after adjusting for all other factors in the combined sample, as well as the urban and rural samples ($P<0.01$). The greatest increase in the odds of vaccination was found when mothers had reached secondary level education. For the combined sample, the odds (95% *CI*) of measles vaccination amongst children whose mothers had primary level education was 1.582 (1.299, 1.926) times higher than children whose mothers had no education. This increased to 2.306 (1.867, 2.847) when the mother had secondary education and 2.301 (1.710, 3.097) for higher education. Similar patterns were produced for the urban and rural sample.

For the combined sample, measles vaccination coverage was significantly and positively correlated with wealth. Compared to the poorest quintile, the odds of measles vaccination were significantly higher ($P<0.01$) in the poorer, middle, richer and richest quintiles. The same pattern was found for wealth quintiles in the rural sample, however, the odds of measles immunisation did not differ significantly across wealth quintiles in the urban sample.

The number of children under-five years living in the household was significantly and negatively correlated with measles immunisation coverage. The result was similar for the combined, urban and rural samples, with the odds of immunisation decreasing by about 1.3 ($P<0.01$) for every one extra child living within the household after the second child.

3.3. Access to health services

Factors related to accessing health services were significant determinants of measles vaccination. As shown in Table 2, the presence of a skilled attendant at the child's birth and receipt of postnatal check-ups were significant ($P<0.01$) positive correlates of measles vaccination. The odds of measles vaccination when a skilled birth attendant had been present ranged from 1.631 in rural areas to 1.808 in urban areas. Children who had received a postnatal check-up in the first two months of life were 1.612 to 1.942 times more likely to have received the measles vaccination.

Table 2

Binomial logistic regression results for measles vaccination and maternal age, maternal education, wealth, number of children per household, skilled birth attendants and postnatal check-ups [*OR*(95% *CI*)].

Variables in the model		Combined (n = 14 264)	Urban (n = 5 420)	Rural (n = 8 844)
Type of residence	Urban*	1	–	–
	Rural	1.066 (0.956, 1.190)[a]	–	–
	Maternal age	1.109 (1.054, 1.167)[c]	1.168 (1.057, 1.291)[c]	1.086 (1.023, 1.152)[c]
	Maternal age squared	0.999 (0.998, 0.999)[c]	0.998 (0.996, 0.999)[c]	0.999 (0.998, 1.000)[b]
Maternal education	No Education*	1	1	1
	Primary	1.582 (1.299, 1.926)[c]	1.981 (1.198, 3.276)[c]	1.534 (1.237, 1.902)[c]
	Secondary	2.306 (1.867, 2.847)[c]	2.790 (1.667, 4.671)[c]	2.262 (1.791, 2.858)[c]
	Higher	2.301 (1.710, 3.097)[c]	2.748 (1.536, 4.916)[c]	2.006 (1.339, 3.005)[c]
Wealth	Poorest*	1	1	1
	Poorer	1.307 (1.163, 1.468)[c]	1.066 (0.782, 1.454)[a]	1.385 (1.219, 1.574)[c]
	Middle	1.436 (1.249, 1.653)[c]	1.085 (0.798, 1.475)[a]	1.638 (1.384, 1.937)[c]
	Rich	1.537 (1.304, 1.812)[c]	1.290 (0.937, 1.777)[a]	1.542 (1.240, 1.918)[c]
	Richer	1.544 (1.268, 1.878)[c]	1.191 (0.839, 1.689)[a]	1.423 (1.033, 1.961)[b]
	Children per household	0.774 (0.725, 0.828)[c]	0.777 (0.688, 0.877)[c]	0.773 (0.713, 0.837)[c]
Child sex	Male*	1	1	1
	Female	1.055 (0.974, 1.143)[a]	1.078 (0.936, 1.243)[a]	1.044 (0.947, 1.150)[a]
Skilled birth attendant	No*	1	1	1
	Yes	1.656 (1.503, 1.824)[c]	1.808 (1.466, 2.230)[c]	1.631 (1.461, 1.820)[c]
Postnatal check-up	No*	1	1	1
	Yes	1.692 (1.524, 1.878)[c]	1.942 (1.590, 2.371)[c]	1.612 (1.424, 1.824)[c]

*Island region, religion, paternal education, maternal and paternal occupation, knowing where to go for medical care, distance to medical care, access to a vehicle, having to take transport to medical care, mother involved in child treatment decisions results not shown here due to space considerations. *OR* = Odds ratio; *CI* = 95% Confidence interval; *Reference category; [a]$P>0.05$, [b]$P<0.05$, [c]$P<0.01$.

4. Discussion

The present study investigated correlates of measles vaccination among Indonesian children under-five years of age using data from a nationally representative survey. Overall 73% of children received the vaccination. After controlling for all other factors, maternal age, maternal education, wealth, the number of children per household, the use of a skilled birth attendant, and postnatal check-ups were significant correlates of measles vaccination.

The findings on factors influencing measles vaccination coverage in Indonesia are in line with findings from other developing nations. The discrepancies between measles immunisation coverage determined via the 2007 DHS survey and official reports indicates a weakness of surveillance systems and highlights a need for quality assurance of vaccination data. In addressing similar heterogeneity in vaccination data in Burkina Faso, Haddad *et al*[21] recommended: (1) strengthening administrative data systems; (2) implementing indicators that are insensitive to population mobility; (3) integrating surveys into monitoring processes at the subnational level; and (4) actively promoting the use of coverage information by local personnel and district-level staff.

The correlation between maternal age and measles vaccination coverage is well studied. The current study found a U-shaped pattern between immunisation levels and maternal age, suggesting that the likelihood of child measles immunisation is lower for both younger and older mothers. This finding is consistent with that of Patra[22], who found the same pattern using data from the Indian National Family Health Survey. The results produced here extend the patterns found by Reynolds, Wong and Tucker in their analysis of previous IDHS data[23]. These authors found that young Indonesian mothers were significantly less likely to use immunisation. However, the range of ages used to define young and older mothers in this study was limited to those under 18 years and those 19-23 years. It is likely that the differences in the impact of maternal age on childhood immunisation across populations are mediated by the patterns in other co-existing factors. For example, older mothers are more likely to have more children, traditional beliefs, lower level of education and less access to modern media[24-26].

The importance of maternal education in child health is universally recognised. However, Muslim nations have, in general, lower rates of female education compared with global average. Despite being a secular country, Indonesia is the largest Muslim majority country in the world, home to about 190 million Muslims. By 2005, the net enrolment rate into senior secondary schools among Indonesians was 42%. Indonesian women are less likely to complete senior secondary education; compared with men[27]. These findings underscore the need for long-term investments in human capital, particularly for Indonesian females.

The results of the logistic regression analysis indicated that wealth was not significantly correlated with measles immunisation coverage amongst the urban sample. This suggests that the influence of socio-economic status on immunisation coverage may be mitigated by the accessibility of health services. Wealth is a well-established indictor of access to health care services, including immunisation, for both developed and developing countries[28]. In Indonesia and most developing nations, the rural poor are considerably worse off than the urban poor in terms of access to health care[29]. This suggests health services are more easily accessible for all socio-economic groups in urban areas. This result complies with previous investigations of rural households in Indonesia which showed that children who had not received any of the recommended childhood immunisations had significantly lower mean per capita weekly household expenditure[9].

The number of children per household has consistently displayed a negative correlation with immunisation coverage in developing countries and the results presented here are no different[9,17,30]. These results are consistent with the idea of quantity-quality trade off. That is, as the number of children increase, the quality of care they receive decreases. This is because limited family resources are spread further, reducing the level of investment received by each child[17,31]. Given that immunisation services are available free of charge in Indonesia, time constraints, rather than economic constraints, may be more relevant.

Access to health services such as skilled birth attendants and postnatal check-ups is positively correlated with receipt of measles vaccination. The Indonesian village midwife program, which began in 1989, places medically trained midwives in local communities. The program was initiated in an attempt to attenuate urban-rural and socioeconomic disparities in maternal and child health[32,33]. In addition to providing skilled birth assistance, these health workers also provided antenatal and perinatal care, nutrition and reproductive advice and immunisation services[34]. It is likely that this program has facilitated continuity of care from birth to postnatal and early childhood health. However, problems in retaining midwives in rural areas and facilitating access for poor and vulnerable groups may account for the continuing socioeconomic and urban-rural disparities in vaccination coverage among Indonesia children[35,36].

When interpreting these results, consideration of the study limitations is required. The choice of variables included in the study relied on the data available in the IDHS dataset. Therefore, other potential indicators of vaccination coverage, such as antenatal care, could not be assessed. Revision of the original response categories from the IDHS may also have influenced the results. The sample contained a higher proportion of rural residents. However, the impact of this potential bias was overcome by analysing urban and rural samples separately.

Using data from a nationally representative and randomly sampled survey this study has shown that a number of socio-demographic and health care variables are correlated with the delivery and uptake of first dose measles vaccination in Indonesia. As highlighted by the disparity between IDHS and officially reported vaccination coverage, measles vaccination rates in Indonesia are sub-optimal and require urgent multi-sectoral attention. At government level, long term investments in human capital are required in the fields of female education, rural wealth creation, and recruitment, as well as retention of rural health workforce. There is also a need for government funding of improved health education about the importance of vaccinations, to encourage voluntary participation. Improvements in vaccination surveillance will help to enhance the accuracy of data reported by the Indonesia's health ministry. Finally, vaccination is not coterminous with immunisation. A single dose of vaccination at the age of 9 months is associated with, at best, 85% immunisation against measles infection. It is therefore important to develop and equip the health workforce for the second dose of measles vaccination. The WHO recommends that when the first dose of measles vaccination is given at 9 months, the second dose should be given at 15-18 months, not at 60 months as is currently the case in Indonesia.

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgements

Fieldwork and some data analysis related to this manuscript were funded through the Governor Sanderson Scholarship in Population Health (Dr. Haruhisa Handa Leadership Scholarship Program) grant awarded to the first author by the School of Population Health, University of Western Australia.

References

[1] Barrett T. Morbillivirus infections, with special emphasis on morbilliviruses of carnivores. *Vet Microbiol* 1999; **69**(1-2): 3-13.
[2] Furuse Y, Suzuki A, Oshitani H. Origin of measles virus: divergence from rinderpest virus between the 11th and 12th centuries. *Virol J* 2010; **7**: 52-5.
[3] World Health Organization. Measles vaccines: WHO position paper. *Wkly Epidemiol Rec* 2009; **84**: 349-60.
[4] World Health Organization. *Fact sheet No.286 measles*. Geneva: WHO; 2009.[online]. Available from: http://www.who.int/mediacentre/factsheets/fs286/en/print.html [Accessed on May 20, 2010].
[5] Heywood AE, Gidding HF, Riddell MA, Mclntyre PB, Maclntyre CR, Kelly HA. Elimination of endemic measles transmission in Australia. *Bull World Health Organ* 2009; **87**(1): 64-71.
[6] United Nations Development Programme. *Human development report 2009-HDI rankings*. New York: UNDP; 2009. [online]. Available from: http://hdr.undp.org/en/statistics/ [Accessed on March 5, 2010].
[7] World Bank. *Indonesia-data*. Washington DC: The World Bank Group; 2010. [online]. Available from: http://data.worldbank.org/country/indonesia [Accessed on October 7, 2010].
[8] Central Intelligence Agency. *The world factbook*. Washington DC: CIA; 2009. [online]. Available from: https://www.cia.gov/library/publications/the-world-factbook/geos/id.html [Accessed on April 22, 2010].
[9] Semba RD, de Pee S, Berger SG, Martini E, Ricks MO, Bloem MW. Malnutrition and infectious disease morbidity among children missed by the childhood immunization program in Indonesia. *Southeast Asian J Trop Med Public Health* 2007; **38**(1): 120-9.
[10]World Health Organization Regional Office for South East Asia. *Measles and rubella fact sheet SEAR 2008-2009*. New Delhi: WHO Regional Office for South East Asia; 2009. [online]. Available from: http://www.whosrilanka.org/LinkFiles/Health_Information_Measles_and_Rubella_Fact_Sheet_-_SEAR_2008_-_2009.pdf [Accessed on March 2, 2010].
[11]Muhadir A. *"BIAS" Indonesia school based immunization program*. New York: Global Immunization Meeting; 2009.
[12]Statistics Indonesia and Macro International. Indonesia demographic and health survey 2007. Calverton: BPS and Macro International; 2008.
[13]Murray CJL, Shengelia B, Gupta N, Moussavi S, Tandon A, Thieren M. Validity of reported vaccination coverage in 45 countries. *Lancet* 2003; **362**(9389): 1022-7.
[14]Langsten R, Hill K. The accuracy of mothers' reports of child vaccination: evidence from rural Egypt. *Soc Sci Med* 1998; **46**(9): 1205-12.
[15]Anand S, Barnighausen T. Health workers and vaccination coverage in developing countries: an econometric analysis. *Lancet* 2007; **369**(9569): 1277-85.
[16]Antai D. Inequitable childhood immunization uptake in Nigeria: a multilevel analysis of individuals and contextual determinants. *BMC Infect Dis* 2009; **9**: 181.
[17]Sia D, Fournier P, Kobiane J-F, Sondo B. Rates of coverage and determinants of complete vaccination of children in rural areas of Burkina Faso (1998-2003). *BMC Public Health* 2009; **9**(1): 416.
[18]UNICEF Indonesia. *A supplementary measles immunization campaign. Banda Aceh: UNICEF; 2009*. [online]. Available from: http://www.unicef.org/indonesia/media_11607.html [Accessed on March 2, 2010].
[19]Pallant J. *SPSS survival manual: a step by step guide to data analysis using SPSS for Windows 3rd ed*. Maidenhead: Open University Press; 2007.
[20]World Health Organization. *Measles and rubella fact sheet SEAR 2008-2009*. New Delhi: WHO SEARO; 2009. [online]. Available from: http://www.searo.who.int/vaccine/LinkFiles/EPI2008/MSLRBL08.pdf [Accessed on October 10, 2010].
[21]Haddad S, Bicaba A, Feletto M, Fournier P, Zunzunegui MV. Heterogeneity in the validity of administrative-based estimates of immunization coverage across health districts in Burkina Faso: implications for measurement, monitoring and planning. *Health Policy Plan* 2010; **25**(5): 393-405.
[22]Patra N. Exploring the determinants of childhood immunisation. *Economic and Political Weekly* 2008; **43**: 97-104.
[23]Reynolds HW, Wong EL, Tucker H. Adolescents' use of maternal and child health services in developing countries. *Int Fam Plan Perspect* 2006; **32**(1): 6-16.
[24]Streatfield K, Singarimbun M, Diamond I. Maternal education and child immunization. *Demography* 1990; **27**(3): 447-55.
[25]Perry H, Weiebach R, Hossain I, Islam R. Childhood immunization coverage in zone 3 of Dhaka City: the challenge of reaching impoverished households in urban Bangladesh. *Bull World Health Organ* 1998; **76**(6): 565-73.
[26]Partha D, Bhattacharya BN. Determinants of child immunization in four less-developed states of north India. *J Child Health Care* 2002; **6**(1): 34-50.
[27]Suryadarma D. *Why are muslims left behind in education? Evidence from Indonesia*. Canberra: Australian National University; 2009. [online]. Available from: http://www.uwa.edu.au/__data/assets/pdf_file/0006/520467/Suryadarma,_Daniel,_PhD_Conf_Paper.pdf [Accessed on October 10, 2010].
[28]Marks JS, Halpin TJ, Irvin JJ, Johnson DA, Keller JR. Risk-factors associated with failure to receive vaccinations. *Pediatrics* 1979; **64**(3): 304-9.
[29]Thang NM, Bhushan I, Bloom E, Bonu S. Child immunization in Vietnam: situation and barriers to coverage. *J Biosoc Sci* 2007; **39**(1): 41-58.
[30]Bondy JN, Thind A, Koval JJ, Speechley KN. Identifying the determinants of childhood immunization in the Philippines. *Vaccine* 2009; **27**(1): 169-75.
[31]Becker GS, Lewis HG. On the interaction between the quantity and quality of children. *J Polit Econ* 1973; **81**(2): S279-88.
[32]Bell J, Curtis SL, Alayon S. *Trends in delivery care in six countries. DHS analytical studies NO. 7*. Maryland: ORC Macro and Intrnational Research Partnership for skilled Attendance for Everyone (SAFE); 2003.
[33]Hatt L, Stanton C, Makowiecka K, Adisasmita A, Achadi E, Ronsmans C. Did the strategy of skilled attendance at birth reach the poor in Indonesia? *Bull World Health Organ* 2007; **85**(10): 774-82.
[34]Shankar A, Sebayang S, Guarenti L, Utomo B, Islam M, Fauveau V, et al. The village-based midwife programme in Indonesia. *Lancet* 2008; **371**(9620): 1226-9.
[35]Kruske S, Barclay L. Effect of shifting policies on traditional birth attendant training. *J Midwifery Womens Health* 2004; **49**(4): 306-11.
[36]World Health Organization Regional Office for South East Asia. Indonesia: national health system profile. New Delhi: WHO SEAR; 2006. [online]. Available from: http://www.searo.who.int/LinkFiles/Indonesia_CHP-Indonesia.pdf [Accessed on March 2, 2010].